

## SOLUBILITY

### Purpose:

This activity will give students an opportunity to observe the solubility of a solid in various liquids.

### Concepts:

1. Solubility depends on properties of both the solids and the liquids forming a solution.
2. Solubility of the host rock is important to repository performance.

### Duration of Lesson:

One 50-minute class period.

### Objectives:

As a result of participation in the lesson entitled *Solubility*, the learner will be able to:

1. determine the relative solubility of a mineral in a given solution; and
2. apply his/her observations and conclusions to the significance of the solubility of minerals to the geologic repository.

### Skills:

Drawing conclusions, hypothesizing, measuring, observing, recording data, working in groups

### Vocabulary:

Saturated, soluble, solubility

### Materials:

Activity Sheets  
*Solubility*, p. 191

### Videotape

*Science, Society, and America's Nuclear Waste Teleconference Series* (available free of charge from the OCRWM National Information Center, 1-800-225-6972; within Washington, DC, 202-488-6720)

### Other

sodium chloride (NaCl — table salt)  
distilled water  
salts for making artificial sea water  
anhydrous isopropyl alcohol (>99%)  
balance (capable of weighing as little as 0.1 gram)  
graduated cylinders (50 - 100 mL)

3 clear glass containers (vials, beakers, etc.)  
laboratory stirring rod (or coffee stirrer)  
glassware for mixing sea water  
grease pen or pen and stick-on labels

### Suggested Procedure:

1. The purpose of this activity is to demonstrate, visually, the range of solubility of a common mineral in three different liquids. The mineral used in this activity is halite or common table salt. It is an ionic solid with sodium cations ( $\text{Na}^+$ ) ionically bound to chloride anions ( $\text{Cl}^-$ ).
2. Ionic solids are most soluble in “polar” liquids, like water, where the liquid molecules have charged “sides.” Non-polar liquids, such as isopropyl alcohol, cannot effectively dissolve an ionic solid.
3. Before students begin this experiment, it may be helpful to discuss the concept of solubility and how it relates to siting the geological repository. The following suggested discussion questions may prepare students to better understand the purpose of this experiment and to formulate educated hypotheses.

### Suggested Discussion Questions:

1. What happens to salt when it dissolves in a polar liquid like water? Has it magically vanished? Is it no longer there?

*(Students should understand that the salt does not “vanish,” but that it breaks up into smaller portions, sodium and chlorine ions. These ions are attracted to the positive and negative poles of the water molecules.)*

2. Many substances are soluble in water. Can you think of examples of such substances?

*(Answers should vary widely. Sugar, powdered tea, hot-chocolate mix, instant coffee, etc.)*

3. Do all solids dissolve easily in water? Can you think of examples of a substance that does not dissolve easily in water?

*(No. Flour, cocoa, butter, oil, etc.)*

4. Is there a limit to the amount of solid that you could dissolve in a certain volume of water?

*(Yes, at a certain point the water will become saturated with the dissolved ions and the solid will remain undissolved.)*

5. How does heat affect the solubility of a substance? Think about putting sugar into coffee or tea or even about dissolving a packet of jello mix.

*(Usually, more of a solid can be dissolved into a liquid when it is warm than when it is cold.)*

6. Can you think of any other factors that might improve the solubility of a substance?

*(Shaking or stirring may improve solubility.)*

4. Once students seem to understand some basic concepts relating to solubility, have them read through the experiment independently.
5. It may be necessary to ask students procedural questions to ensure that they understand what they will do in this activity.
6. Before beginning the activity, it may be useful to discuss how distilled water becomes Great Salt Lake water. Remind students that they are modeling the process through which minerals are weathered and incorporated into sea or lake water. Rainwater, not very different from distilled water, reacts with rock minerals and dissolves the soluble parts. This results in the mineral slowly falling apart and the original rainwater, which is now river or ground water, getting saltier. The water continues to react with other minerals and dissolves those parts that it can until it becomes saturated with dissolved salts and is no longer able to react. By making such a concentrated solution, students are modeling the natural process of evaporation which concentrates weathered minerals like salts in sea or lake water.
7. It is suggested that students work in groups of two to four to derive maximum benefit from this experiment. Each student should be prepared with activity sheets and his/her text to make predictions, set up the experiment, and record data as the experiment progresses.
8. Students should be able to follow directions listed in the activity to set up and perform the experiment. Encourage students to allow the NaCl the same amount of time to dissolve in each vial and to stir each vial uniformly.

**Caution students that isopropyl alcohol is a flammable liquid  
and that they should avoid breathing large quantities of the fumes.**

9. To conclude this activity, you may want to discuss the conclusion questions once students have had time to answer them.

#### **Teacher Evaluation of Learner Performance:**

Student participation in classroom discussion and experiment/activity will indicate understanding.